"Going With the Flow"

(Adapted from "Blue Beads" from Discover A Watershed: Watershed Manager
The Watercourse & Project WET International, 2002)

Virginia Science SOLs

6.7, 6.9, LS.4, LS.12

Key Concepts

stream and river processes, benefits of wetlands, water quality monitoring

Vocabulary

headwaters, main stem, mouth, tributary, flood plain, delta, wetland, pool, riffle, first, second, third and fourth order stream, upper, middle and lower reaches

Setting

Classroom with access to open space

Summary

By acting out the parts of a river system, students will be introduced to basic stream and river processes, the unique characteristics and functions of various parts of the system and the importance of protection.

Learning Objectives

Students will:

1. Demonstrate the movement of water through a stream and river system
2. Compare and contrast water quality conditions in different parts of the system

Background Information

Whether you are a fly fisherman enjoying the morning in a Blue Ridge Mountain trout stream, a kayaker paddling on a small Piedmont region river or a family crabbing off a Tidewater pier, there are vastly different aquatic conditions making your activity possible. A stream and river system change both physically and biologically from its source or **headwaters**, to the **mouth**, where it empties in to the ocean or another large body of water. These changes occur along a gradual continuum.

U**pper reaches** typically contain several small headwater streams originating from a variety of sources – snowmelt, surface runoff or discharging underground springs. Headwater streams are classified as **first** and **second** order streams. The smallest, first order streams, have year round water and no tributaries. When two first order streams come together they form a second order stream. Typically, these streams are no more than a few feet wide, travel over a fairly steep slope and are surrounded by a canopy of trees or other vegetation. Water often cascades over boulders and fallen logs, forming a series of waterfalls and pools in stair step fashion. The shade and air-water interchange help keep headwaters streams cool and well-oxygenated. Upper reaches are characterized by V-shaped channels and boulder and cobble bottoms which provide a substrate for benthic macroinvertebrates. Organic matter from the surrounding canopy forms the basis of the in-stream food chain, since the stream itself does not receive substantial sunlight.

Downstream, in the m**iddle reaches** of the river system, **tributaries** (other streams and small rivers) have joined the main system and increased the water volume. The river is bigger and deeper

Background, continued

now and classified as a **third or fourth order stream** The main channel has widened into a U-shape and stream banks are eroded laterally in places. The river periodically overflows on to the **flood plain**, relatively flat land stretching from either side. Built by the material being deposited by the river, flood plain soils are often rich in nutrients, making them popular agricultural areas. Since the gradient of the river has decreased, there is no longer a stair-step appearance. The flowing water alternates between deeper pools and **riffles**, shallower areas of fast moving water and rocks that break the surface. In the middle reaches, there are fewer boulders and much more gravel and silt. Organic matter still falls into the water, however sunlight now reaches the river, allowing photosynthetic algae to grow and become part of the food base. A slightly different community of benthic organisms exists, with more "grazers" able to find food on the algae covered rocks.

In the **lower reach**, the **main stream river**, with its wide, deep channel dominates the scene. The river flows in big, arching meanders through a relatively flat flood plain and broad valley. The bottom substrate now consists of sand, gravel and mud. As the river flows toward its mouth, the load of sediment may grow beyond the river's capacity to carry it and a delta is formed from the deposits. Side channels and **wetlands**, (transition zones between upland and deep-water environments with characteristic soils and vegetation) are commonly interspersed in the lower reaches. The riparian zone is broad and complex, with different kinds of grasses, shrubs and trees. It only covers the sides of the river, so most of the water is un-shaded. However, high turbidity levels prevent sunlight from reaching the bottom of the river. Fine particles replace organic debris and algae as the food source for primary consumers.

Materials

- Sturdy stools or chairs
- Assorted craft supplies for making wetland plants and any other props, i.e. construction paper, a roll of green party streamer, tape, pipe cleaners, straws, etc.
- Bottles of Soap Bubbles
- A box of game chips (Red = Sediment, White = Oxygen, Blue = Water, Write a "S" on several blue chips with a permanent marker to represent saltwater)
- Optional – Plastic cups (1 per person) can be used to hold the games chips as they are being passed.
- A large container to collect the water/chips at the "mouth"

Procedure

1. Review the main parts of a stream/river system and the basic procedure that will be used by the group to model them, prior to conducting the activity. Once the students begin building their river system, it will be difficult to give detailed explanations.

2. Students may wish to help make the props for the activity such as silly "hats" to represent wetland plants. Teachers may wish to let the students contribute their own ideas about how to act out the parts of a river system, once they are familiar with the major concepts. The overall shape of the student mass is similar to the branching pattern of leaf, the human circulatory system or of course, a river on a map. The teacher should point out where each main reach of the river system: upper, middle and lower will be located within the open space available. The following is one possible method. It can be simplified if needed.

3. Select four to six students to serve as the headwaters area by standing on sturdy objects, such as stools or chairs. This represents higher elevation. (If accessible, bleachers can be used or if the activity is being conducted outdoors, any natural slope can be utilized by assembling the headwaters at the top of the hill and so on.) The students should be positioned an arm's length apart. Two additional students can serve as their spotters and contribute "oxygen" to the system in the form of soap bubbles. One-two other students will be needed to pass unmarked blue and white game chips to their elevated classmates and thus begin the water flow. A ratio of about one white to four blue chips would work but teachers should remind students of the relatively small concentrations of oxygen in water vs. the atmosphere. (i.e. eight-10 parts per million) While headwater students are accepting and passing water chips, they can move up and down or dance about to represent the drama of falling water.

   Optional – Seasonal changes in stream velocity can be represented if the distance between two students is known and the time interval between passing of the game chips is varied. A volume of water can be assigned to each chip to calculate changes in flow rate.

4. The elevated students will hand their "water and oxygen" to the four to six students who represent the middle reach of the river system. These students should stand approximately one arm's length apart in a branching pattern with relatively straight lines. If there is more than one headwaters stream flowing in there should be a student positioned to receive chips from each. Additional tributaries, (two to three more students) are now coming in from both sides of the mid section, so the middle reach students will receive chips from two different directions. They will get blue and white chips from the headwaters and blue and red (sediment) chips at a ratio of 2:1 from the tributaries. The middle reach students should be asked to drop every other white chip they receive on the floor to represent lower dissolved oxygen levels.

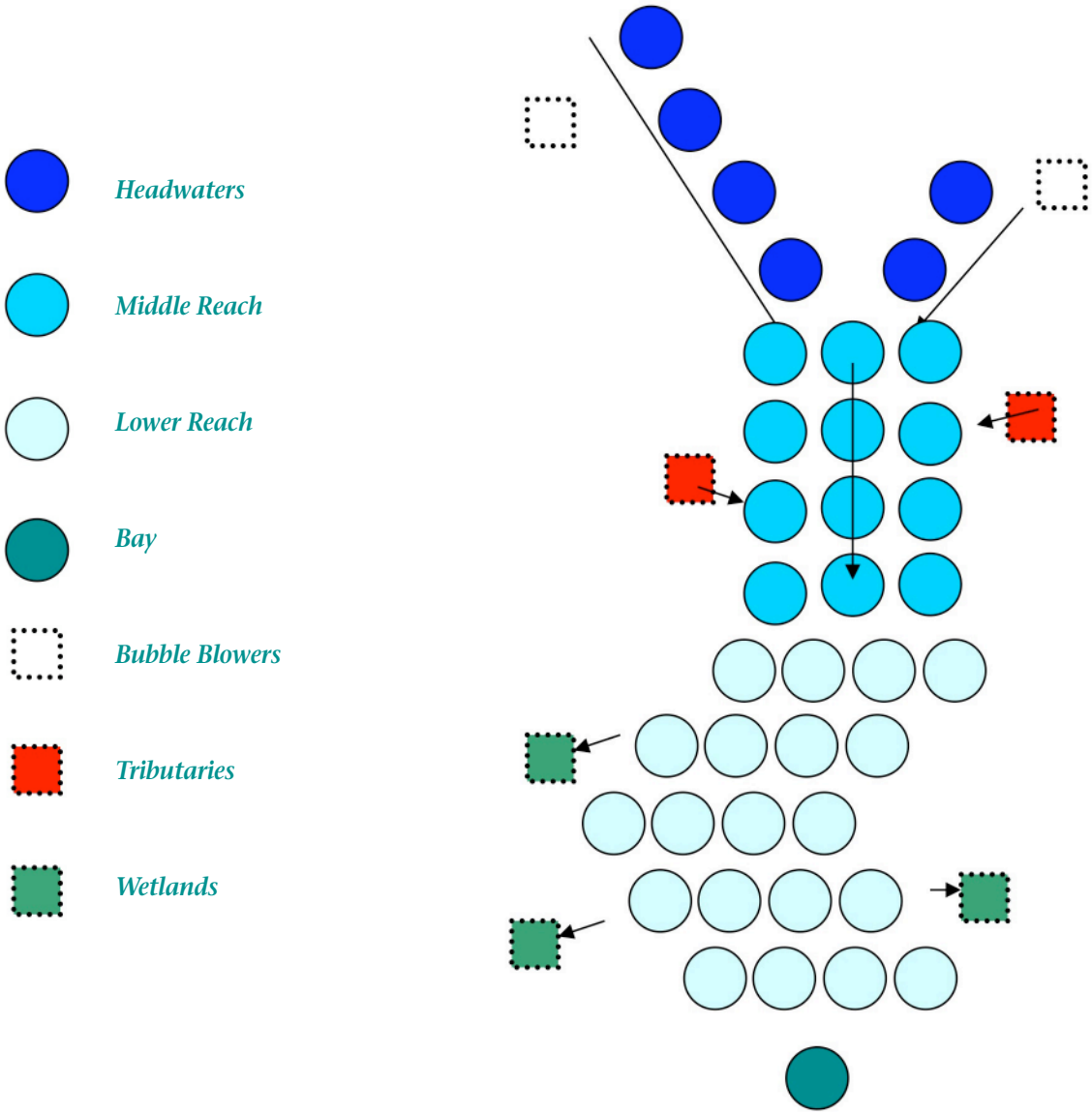
5. The remainder of the class will form the lower reach of the river system including adjacent wetlands. If it can be executed safely, these students can sit (to represent the lowest elevation) three to four abreast (so they are the widest point) in a curvy line to represent meandering. Lower reach students should be asked to drop every other white O_2 chip they are given by the middle reach. One student should be positioned at the mouth and accept the water/chips that have been handed down and place them in the container. At the same time, he/she or another student can pass back up blue chips marked with an S, to represent saltwater intrusion. These can be circulated haphazardly through the lower reach. A student at each side of the lower reach should hand additional red chips to the main stem students to represent the turbid conditions. Interspersed with them should be two wetland plants (students) on each side of the river. Main stem students should be asked to hand red chips back to the wetland plants. This represents the wetlands ability to slow water and filter out pollutants. Each plant can only accept a maximum of five red chips however. Any additional chips need to be passed down stream.

6. After the water flow has been exhausted and the activity completed, students should examine and discuss the contents of the container at the mouth of the river system. Discussions questions may include:
   - How would you describe the general conditions at the mouth of this river system?
   - What type of organisms do you think can be sustained here?
   - How might the seasons and weather influence the flow of water through the system?
   - What could be done to make the lower reach less turbid?
   - How does this representation compare to the watershed our school is in?

Summary of the Activity

River Section	What They Do	What They Receive from Whom	What They Pass to Whom
Headwaters/Upper Reach	4-6 elevated students, an arm's width apart, dramatically move up and down while accepting and passing chips downstream. 1-2 students blow bubbles	1 or 2 students if you have two first order streams forming a second order stream, hand blue (water) and white (O2) chips (4:1) to the elevated students	All chips are passed down to the middle reach students who are standing
Middle Reach	4-6 more students stand 2-3 abreast at a slight diagonal, receiving chips from two directions and passing them downstream	Blue and white chips will be passed from the headwaters. Every other white chip is dropped on the floor. Blue and red chips are being passed from the sides by the tributaries.	All of the blue and red chips and half of the white chips are passed down to the lower reach students
Lower Reach	Sitting 3-4 abreast in a wavy line, 9-12 students receive all chips from the middle reach and additional red chips from students at each side. A portion of the red and white chips are deposited. One student at the mouth takes saltwater chips from the bay and passes them back up the lower reach.	Lower reach students accept chips of all colors from the middle reach students. Every other white (DO) chip should be dropped on the floor. Additional red chips are being added from the sides to represent the turbid conditions. Wetland plant people can accept up to 5 of the red chips a piece and should keep them. The river mouth people draw blue chips with an S for saltwater out of the Bay container and pass back upstream randomly.	Eventually, all of the chips except the red chips the wetland plants kept are passed down to the Bay container so the results can be discussed.

Diagram of the Activity



Reflection and Extension

Individual cooperation and participation level can be observed during the activity. Student groups can discuss and record answers to questions about conditions in their part of the stream and river system or prepare a poster, mural or graphic representation.

Resource

Streamkeeper's Field Guide by Tom Murdoch and Martha Cheo, The Adopt-A-Stream Foundation